Status of Double-crested Cormorant *Phalacrocorax auritus* research and management in North America

Scott J. Werner & Shauna L. Hanisch

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Die Ohrenscharbe, die häufigste der sechs Kormoranarten Nordamerikas, hat wieder große Bestände ausgebildet, nachdem sie in den 1960er und frühen 1970er Jahren beinahe ausgerottet worden war. Verbesserte Richtlinien zum Schutz der Umwelt und die Verfügbarkeit geeigneter Beutefischarten unterstützen die Erholung der Ohrenscharbenpopulationen seit der Mitte der 1970er Jahre. Die Bestände haben in den meisten geographischen Regionen bis zur Gegenwart kontinuierlich zugenommen. Die nordamerikanische Ohrenscharbenpopulation wurde auf ein bis zwei Millionen Vögel geschätzt. Sorgen über eine mögliche Schädigung von Fischbeständen in Fischzuchtanlagen und Angelgewässern, anderer Vogelarten, der Vegetation, von Privateigentum und der lokalen Wirtschaftskraft wurden geäußert. Wirtschaftliche Schäden in Welszuchtanlagen (*Ictalurus punctatus*, Getüpfelter Gabelwels) wurden bisher am besten dokumentiert. Aufgrund der gewaltigen Zunahme der Ohrenscharbenbestände und der sozioökonomischen und biologischen Bedeutung der geäußerten Befürchtungen wird der „United States Fish and Wildlife Service" (USFWS) in Kooperation mit dem „USDA/APHIS/Wildlife Services" eine Einschätzung der von der Ohrenscharbe ausgehenden Umwelteinflüsse sowie der Wirkung verschiedener Managementalternativen zur Reduzierung des Konfliktes zwischen Mensch und Vogel vornehmen. Der USFWS plant, den abschließenden Bericht („Environmental Impact Statement", EIS) im Frühjahr 2003 vorzulegen.

Key words: Aquaculture, depredation, Environmental Impact Statement, fish, Double-crested Cormorant, *Phalacrocorax auritus*, waterbird.

1. Trends in DCCO populations and movements

Double-crested Cormorant (DCCO) populations have increased since the mid-1970s, following several years of serious reproductive failure associated with organochlorine contaminants (HATCH 1995; HATCH & WESELOH 1999). A conservative estimate of the total population of DCCOs in the United States and Canada is greater than one million birds, including breeding and non-breeding individuals, but is probably closer to two million (HATCH & WESELOH 1999; TYSON *et al.* 1999). While the overall rate of growth in the United States and Canadian populations slowed during the early 1990s (TYSON *et al.* 1999), there are still significant population increases occurring in some areas. For example, the Great Lakes population of DCCOs probably reached a low of around 200 nesting pairs sometime between 1968 and 1973 (LUDWIG 1984). This population was estimated to include 38,000 DCCOs in 1991 (WESELOH *et al.* 1995) and 93,000 in 1997 (TYSON *et al.* 1999). During the 2000 breeding season, the Great Lakes population was estimated at 115,000 DCCO nests based on a partial census and extrapolated growth rates from surveyed islands (WESELOH *et al.* 2002). The Atlantic and Pacific Coast DCCO populations are generally increasing, though trends vary among states and provinces (WIRES *et al.* 2001).

The growth in breeding populations in eastern North America has led to increased abundance of birds wintering in the southeastern United States (JACKSON & JACKSON 1995). The number of DCCOs wintering on the alluvial plain (delta region) in western Mississippi has increased nearly 225 percent since the early 1990s (GLAHN *et al.* 2000a). Over 60,000 DCCOs have wintered each year in the delta region of Mississippi since the winter of 1997/98 (in over 75 night roosts), despite the implementation of a standing Depredation Order (USFWS 1998a) that allows aquaculture producers in thirteen states to take, without a federal permit, DCCOs that are consuming, or about to consume, cultured fish on their aquaculture facilities.

An additional 7000 to 17,000 DCCOs at 36 night roosts were observed via aerial surveys near Arkansas catfish farms in February - April 1999 (S. J. WERNER, unpublished data). Moreover, the abundance of resident cormorants near southeastern aquaculture facilities has increased in recent years, and several breeding colonies have been observed in portions of the traditional wintering range in Mississippi and Arkansas (REINHOLD *et al.* 1998).

Although much has been learned from over 8000 DCCOs that have been recovered after being uniquely banded as nestlings (DOLBEER 1991), the breeding distribution of DCCOs found near southeastern aquaculture facilities remains unknown. Double-crested Cormorants observed near aquaculture facilities in the southeastern United States migrate from northern breeding colonies to the southeastern United States during the fall (September - October) and return to their traditional breeding colonies in the northern United States and Canada in spring (March - June). To determine the specific breeding distribution of DCCOs associated with aquacultural depredation, a study was initiated in November 1999 using satellite transmitters installed on 25 cormorants in each of two years. A similar study was initiated in May 2000 to monitor the foraging distribution of 25 DCCOs captured and fitted with satellite transmitters in each of two years at a traditional breeding colony in eastern Lake Ontario in western New York.

Preliminary results from the satellite telemetry study in Alabama, Arkansas, Louisiana, and Mississippi indicate that DCCOs generally remained near aquaculture facilities where they were captured from November 1999 through March 2000 (WERNER *et al.* 2000). Although DCCOs associated with the second satellite telemetry study in New York remained near the breeding colony in the eastern basin of Lake Ontario from May - September 2000 (WERNER *et al.* 2001), preliminary results indicate that approximately 39 percent of DCCOs left the breeding colony subsequent to egg oiling activities during the 2000 and 2001 breeding seasons (DORR *et al.* 2002). Future results of these studies of cormorant movements will enable resource managers to develop biologically realistic alternatives for managing DCCO impacts to commercial and recreational fisheries.

2. Conflicts associated with DCCOs in the United States

Concerns associated with DCCOs include impacts on aquaculture and open-water commercial fisheries, recreational (sport) fisheries, colonial waterbird populations, vegetation, public and private property, and human health. GLAHN *et al.* (1995) found that approximately half of the diet (by mass) of DCCOs collected in northwestern Mississippi was composed of Channel Catfish *Ictalurus punctatus* fingerlings that averaged 16 cm in length. The remaining diet was composed predominantly of American Gizzard Shad *Dorosoma cepedianum*. The energetic requirements of DCCOs, their relative abundance, and the state of the aquaculture industry (i.e., acreage and production) were used by GLAHN & BRUGGER (1995) to predict the economic impact of DCCOs on catfish aquaculture. These authors estimated that the cost of replacing the 18 - 20 million catfish fingerlings consumed by DCCOs each year would be approximately $ 2 million (USD). Given the increase in DCCO wintering populations since the early 1990s, GLAHN *et al.* (2000a) more recently estimated that this replacement cost would be approximately $ 5 million.

Recent controlled foraging experiments have elucidated the impacts of DCCOs on the gross (i.e., at-harvest) production of Channel catfish (GLAHN & DORR 2002). Each pond in this study was stocked with 12,355 fish·ha^{-1} and an equal biomass of Golden Shiners *Notemigonus crysoleucas* to simulate unmarketable (i.e., buffer prey) fishes in commercial ponds. After research ponds were divided with plastic mesh screening, one pond half was covered with netting to exclude cormorants during a 10-day predation treatment. Compared to the abundance of catfish harvested at the end of the growing season in control-pond halves (i.e., cormorant exclusion), DCCOs removed approximately 30 percent of catfish in ponds associated with negligible disease-related fish mortality (GLAHN & DORR 2002). These authors also observed a 23 percent decrease in overall pond production (kg·ha^{-1}) where fish disease did not occur, suggesting that DCCO predation was additive to other fish mortality factors. Assuming a 20 percent production loss, economic models suggested a 111 percent loss of annual profits in catfish production that is attributable to DCCO predation (GLAHN *et al.* in press). Considering the value of catfish at harvest (approximately 500 percent of the fingerling replacement cost reported by GLAHN *et al.* 2000a), GLAHN *et al.* (in press) suggested that the actual economic loss to Mississippi catfish farmers (via DCCO predation) may approach $ 25 million per year, or 8.6 percent of annual catfish sales in Mississippi (USDA 2000).

Perhaps the most emotional and controversial conflicts associated with DCCOs are impacts on recreational fisheries. TRAPP *et al.* (1999) conducted a review of cormorant diet studies carried out between 1923 and 1994 and found that of 75 fish species detected as DCCO prey items, only 29 species comprised more than 10 percent of the diet at a specific site. Of those 29 fishes, five species consistently comprised greater than 10 percent of the diet among the reviewed studies: Alewife *Alosa pseudoharengus*, Brook Stick-

leback *Culaea inconstans*, Ninespine Stickleback *Gasterosteus aculeatus*, Yellow Perch *Perca flavescens*, and Slimy Sculpin *Cottus cognatus*. This synthesis confirms that the DCCO is an opportunistic feeder that consumes a diversity of prey.

The majority of the diet literature suggests that the abundance and biomass of prey consumed by DCCOs are composed predominantly of species other than sport and commercial fishes (WIRES *et al.* 2001). Although DCCOs have been reported to negatively impact populations of Smallmouth Bass *Micropterus dolomieu* and other fishes in the Great Lakes region of the United States (SCHNEIDER *et al.* 1999), the literature review conducted by TRAPP *et al.* (1999) "indicated that fish species valued by sport and commercial anglers make up a very small proportion of a cormorant's diet and that these birds have a minor effect on fish populations compared to the effects of sport and commercial fishing, natural predation, and other mortality factors." HATCH & WESELOH (1999) suggested that "cormorant predation and its impacts are not revealed by mere lists of prey or simple percentages." Indeed, interdisciplinary studies are needed to relate cormorant foraging behavior (e.g., predation frequency, intensity, timing, and duration) and North American recreational fisheries data (e.g., production, richness, and abundance trends).

3. Migratory bird regulations and authorities in the United States

The mission of the United States Department of Interior Fish and Wildlife Service ("Service") is "working with others to conserve, protect, and enhance fish, wildlife, and plants and their habitats for the continuing benefit of the American people." In addition to wildlife and fisheries biology, the Service recognizes social, political, and economic realities while achieving its mission (USFWS 1998b). Aside from the Service's responsibilities for the management and conservation of the National Wildlife Refuge System, endangered species, certain marine mammals, and nationally significant fisheries, the Service has the primary statutory authority to manage migratory bird populations in the United States. This authority comes from the Migratory Bird Treaty Act of 1918 (MBTA; 16 U.S.C. 703 et. seq.).

The original treaty was signed by the United States and Great Britain (on behalf of Canada) in 1916 and imposed on the United States the responsibilities to conserve and manage migratory birds internationally, sustain healthy migratory bird populations for consumptive and non-consumptive uses, and restore depleted populations of migratory birds. The cormorant taxonomic family, Phalacrocoracidae, came under the protection of the MBTA in 1972. Since then, DCCOs have been a trust resource managed by the Service for the American people.

The Wildlife Services program of the United States Department of Agriculture's Animal and Plant Health Inspection Service ("APHIS/WS") is responsible for managing conflicts and damages associated with wildlife, including migratory birds. Its mission is to provide leadership in wildlife damage management in the protection of America's agricultural, industrial and natural resources, and to safeguard public health and safety. The chief role of APHIS/WS in DCCO management is to reduce cormorant damage at aquaculture facilities, although they also assist with mitigating damages related to other resources. To that end, APHIS/WS offers assistance in the areas of technical advice and direct damage control (ACORD 1995), and maintains a strong research element through its National Wildlife Research Center. Due to the important role of APHIS/WS in DCCO management and research, the Service invited them to serve as a "cooperating agency" in the development of an Environmental Impact Statement (EIS).

4. Development of the DCCO Environmental Impact Statement (EIS)

The National Environmental Policy Act (NEPA) requires that an EIS be prepared when a "major federal action" with potentially significant impacts to the environment, or with wide-reaching or long-term implications, is proposed. The NEPA was enacted by the United States Congress in 1970 and mandates a particular process of decision-making to "ensure that environmental information is available to public officials and citizens before decisions are made and before actions are taken" (40 CFR 1500). An EIS is a comprehensive analysis that enables federal officials to document the decision-making process and consider the potential impacts of the proposed action, as well as a range of alternative actions, to the natural and human environment. The NEPA process also enables the public to provide input to decision-makers via public comment periods.

The development of an EIS involves several specific steps. The Service published a "notice of intent" in November 1999 that stated its intention to prepare the DCCO EIS and accompanying national management plan aimed at addressing impacts caused by population and range expansion of the DCCO in the contiguous United States. This was followed by a "scoping" period in the spring of 2000, during which ideas and issues of concern were solicited from the public. The Service hosted 12 public meetings in 10 states and received over 1400 written comments from concerned citizens. The draft EIS was published in November 2001 and was followed by an additional pub-

lic comment period and a series of additional public meetings.

The draft EIS reviews the significance of DCCO impacts to human and natural resources, and analyzes the environmental effects of six management alternatives on these resources and DCCO populations. The selected "proposed action" in the draft EIS includes (1) the creation of a "public resource depredation order" to allow state, tribal, and federal fish and wildlife agencies to control DCCOs where necessary to protect public resources and (2) the expansion of the extant "aquaculture depredation order" to allow employees of APHIS/WS to conduct DCCO control at winter roost sites at or near aquaculture facilities. Other alternatives considered (but not selected) in the draft EIS include "no action," or status quo DCCO management; exclusive non-lethal management; increased local damage control; regional population reduction; and a regulated DCCO hunting season.

The purpose of the proposed action is to (1) reduce conflicts associated with DCCOs in the contiguous United States, (2) enhance the flexibility of natural resource agencies in dealing with DCCO-related conflicts, and (3) ensure the conservation of healthy and viable DCCO populations. The final EIS will identify the "final" alternative that can be the proposed action identified in the draft EIS or a combination of one or more alternatives. The Service intends to complete the final EIS in early 2003.

APHIS/WS supports a DCCO management strategy developed jointly by federal and state agencies that includes a combination of alternatives, including, but not limited to, a public resource depredation order, an expanded aquaculture depredation order, and a regional DCCO population-reduction strategy. The purpose of this strategy would be to adequately reduce DCCO damage and negative impacts to aquaculture and hobby fisheries; natural resources, including wild fisheries; property; and human health and safety in an effective, efficient, and timely manner. Management actions should include all efficacious methods, including the use of depredation orders, depredation permits, or any other "permit" that allows the take of DCCOs and their nests and eggs. APHIS/WS believes that this type of management approach would provide an avenue for professional wildlife biologists and natural resource managers to manage DCCO populations in a socially acceptable and biologically controlled manner, and would meet the purpose of the EIS.

5. Present and future DCCO management and research

Present techniques to manage cormorant-related damages in the United States include the issuance of depredation permits, non-lethal harassment, and the standing Depredation Order for aquaculture producers (USFWS 1998a). BEDARD *et al.* (1995) demonstrated that the abundance of DCCOs breeding in the St. Lawrence River Estuary (Quebec, Canada) could be decreased by oiling eggs in accessible ground nests and culling adults in arboreal colonies to reduce recruitment and the breeding population, respectively. Under the MBTA, a federally-issued depredation permit is required to legally kill cormorants in the United States. These permits are issued at the regional level by the Service to protect private property (when economic impacts are documented) and enhance biodiversity, but rarely to protect recreational fisheries. Non-lethal harassment can be conducted without a federal permit.

An example of present, non-lethal management strategies is the dispersal of night-roosts near southeastern aquaculture farms that is commonly conducted by APHIS/WS personnel and fish farmers (MOTT *et al.* 1998; REINHOLD & SLOAN 1999). Although coordinated and intensive roost harassment may temporarily limit DCCO impacts to aquacultural production (TOBIN *et al.* 2002), existing management strategies have not reduced regional DCCO populations in the southeastern United States (GLAHN *et al.* 1996; MOTT *et al.* 1998, GLAHN *et al.* 2000a). Additionally, existing strategies have not effectively addressed conflicts associated with DCCO abundance and related impacts.

GLAHN *et al.* (2000b) recommended a science-based approach for managing DCCOs. This approach includes the evaluation of regional control options (for southeastern aquaculture), an investigation of flyway movements, an assessment of present population management strategies, the development of a DCCO population model to examine measures needed to reduce cormorant populations (see BLACKWELL *et al.* 2002), and the initiation of an integrated cormorant management plan. Several research needs regarding the impacts of regional population management and the monitoring associated with such management still exist for DCCOs. These include DCCO demographics (i.e., age-specific survivorship and fecundity; see FREDERIKSEN & BREGNBALLE 2000a, b) and cormorant impacts to fisheries and habitats throughout North America. The Ontario Ministry of Natural Resources is presently implementing an experimental control program to quantify the response of localized fisheries when DCCO populations are controlled in selected areas. To further address DCCO research needs in North America, the Service and APHIS/WS, as well as state, university, and Canadian stakeholders, should continue to foster collaborative cormorant research among relevant disciplines.

6. Conclusion

Cormorant management is a complex biological and social issue. The complexity associated with national management planning emerges from balancing diverse perspectives. Divergent views regarding DCCO management exist not only among public stakeholders, but also among natural resources professionals. Given the biological, economic, and sociopolitical values associated with the abundance and impacts of DCCOs, alternatives for resolving these conflicts should be biologically and socioeconomically reasonable. The ultimate goal of such management efforts should include the concurrent reduction of DCCO impacts and the continued conservation of viable cormorant populations. Further interdisciplinary research will improve our ability to manage DCCOs in a scientifically responsible manner.

7. Summary

Werner S. J. & S. L. Hanisch 2003: Status of Double-crested Cormorant *Phalacrocorax auritus* research and management in North America. Vogelwelt 124, Suppl.: 369–374.

The Double-crested Cormorant, the most abundant of North America's six cormorant species, has rebounded to high numbers after near extirpation in the 1960s and early 1970s. Enhanced environmental regulations and the availability of prey fishes facilitated the resurgence of Double-crested Cormorant populations by the mid-1970s and numbers have continued to increase steadily in most geographic regions through the present. The North American population of Double-crested Cormorants has been estimated at one to two million birds. Concerns about impacts of Double-crested Cormorants on aquacultural stock, sport fish populations, other birds, vegetation, private property, and local economies have been raised. Economic impacts to Channel Catfish *Ictalurus punctatus* aquaculture are the best documented of these damages. Due to the species' dramatic population increase and the biological and sociopolitical importance of these various concerns, the United States Fish and Wildlife Service, in cooperation with USDA/APHIS/Wildlife Services, will prepare an Environmental Impact Statement to consider the environmental impacts and effectiveness of various management alternatives for reducing human-cormorant conflicts. The Service intends to complete the final Environmental Impact Statement in early 2003.

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Scott J. Werner, Research Wildlife Biologist; United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center; Fort Collins, Colorado 80521, USA. *Scott.J.Werner@aphis.usda.gov*

Shauna L. Hanisch, Wildlife Biologist; United States Department of the Interior, U.S. Fish and Wildlife Service, Division of Migratory Bird Management; Arlington, Virginia 22203, USA.